

Trace element analysis of urban and background aerosols using SR-TXRF

V. Groma, F. Meirer¹, J. Osán, S. Török, C. Strelí, P. Wobrauschek¹, and G. Falkenberg²

KFKI Atomic Energy Research Institute, P.O. Box 49, H-1525 Budapest, Hungary

¹ *Atominstytut der österreichischen Universitaeten TU Wien, Stadionallee 1020 Vienna Austria*

² *Hamburger Synchrotronstrahlungslabor (HASYLAB) at Deutsches Elektronen-Synchrotron (DESY),
Notkestr. 85, 22607 Hamburg, Germany*

The examination of transboundary air pollution is one of the most critical issue between neighbourhood countries in environmental policies. This is especially valid for fine aerosols which are strongly related to the health of citizens and which have recently been proven to be the most harmful to the human health. Air polluting compounds in the gas phase can be measured by high temporal and spatial resolution using optical and remote sensing methods. Our aim is to develop a multielemental analytical technique that has similar capabilities for the total aerosol. Therefore, because of the high temporal resolution (1-10 min) we have chance to identify potential particle sources. SR-TXRF is especially suitable for the analyses of aerosols because of the inherent properties of synchrotron radiation like natural collimation, broad spectral range and high intensity. These qualities in combination with the advantages of the TXRF geometry producing a low background enable the detection of trace and ultra trace amounts (ng/m^3 , pg/m^3) of most elements.

Aerosol samples were collected on silicon wafers at different urban and background locations in Austria and Portugal using a 7 stage May cascade impactor [1]. Since the investigation was focused on the fine aerosol sample fraction, aerosol collection was performed only at stages 5, 6 and 7, with an aerodynamic cut-off diameters of 1, 0.5 and 0.25 μm respectively. Each stage of the May impactor has an impacting slit, therefore the collected particles are deposited on the silicon reflectors as a thin strip with approximate dimensions of 20 mm \times 0.3 mm.

Measurements were performed at HASYLAB Beamline L using the total reflection X-ray fluorescence vacuum chamber [2]. The energy of the synchrotron radiation was tuned to 17.5 keV using the NiC multilayer monochromator and the vertical dimension of the beam set to 1 mm. The Vortex Radiant SDD was provided with a 1.5 mm wide Mo slit collimator to overcome the arising inhomogeneity problems, and to shield the fluorescence of possible contaminants lying beside the strip of collected aerosols. An automatic sample loader was installed to establish the opportunity to measure 8 samples consecutively without the necessity to close the beam shutter and open the vacuum-chamber, resulting significant time saving during the beam time.

The sample holders were mounted with the strip in vertical position and were scanned in 6 steps over a length of 6 mm. To calculate the mass of the present elements from the TXRF measurements a Cr standard with known mass and dimensions identically similar to those of the deposited aerosol particles as external standard was used. Using the sum spectra of the 6 mm scans and the results of the Cr standards the elemental composition of the collected particles could be calculated [3]. Figure 1. a-c shows examples of the collected samples for some typical elements. Because of the extremely high sensitivities offered by the SR-TXRF for aerosol analysis, detection limits achieved for 20 min sampling time are ranging from ng/m^3 for the light elements (Al, Si) to pg/m^3 for the medium Z elements like Rb and Sr in the present matrix (see Table 1.).

Results from the size fractioned aerosol samples performed above collected for extremely short time periods confirm the facts which were previously expected, like Zn and Pb can be related to aereas where traffic sources dominate, or chlorine is leading in particles originated from marine sites.

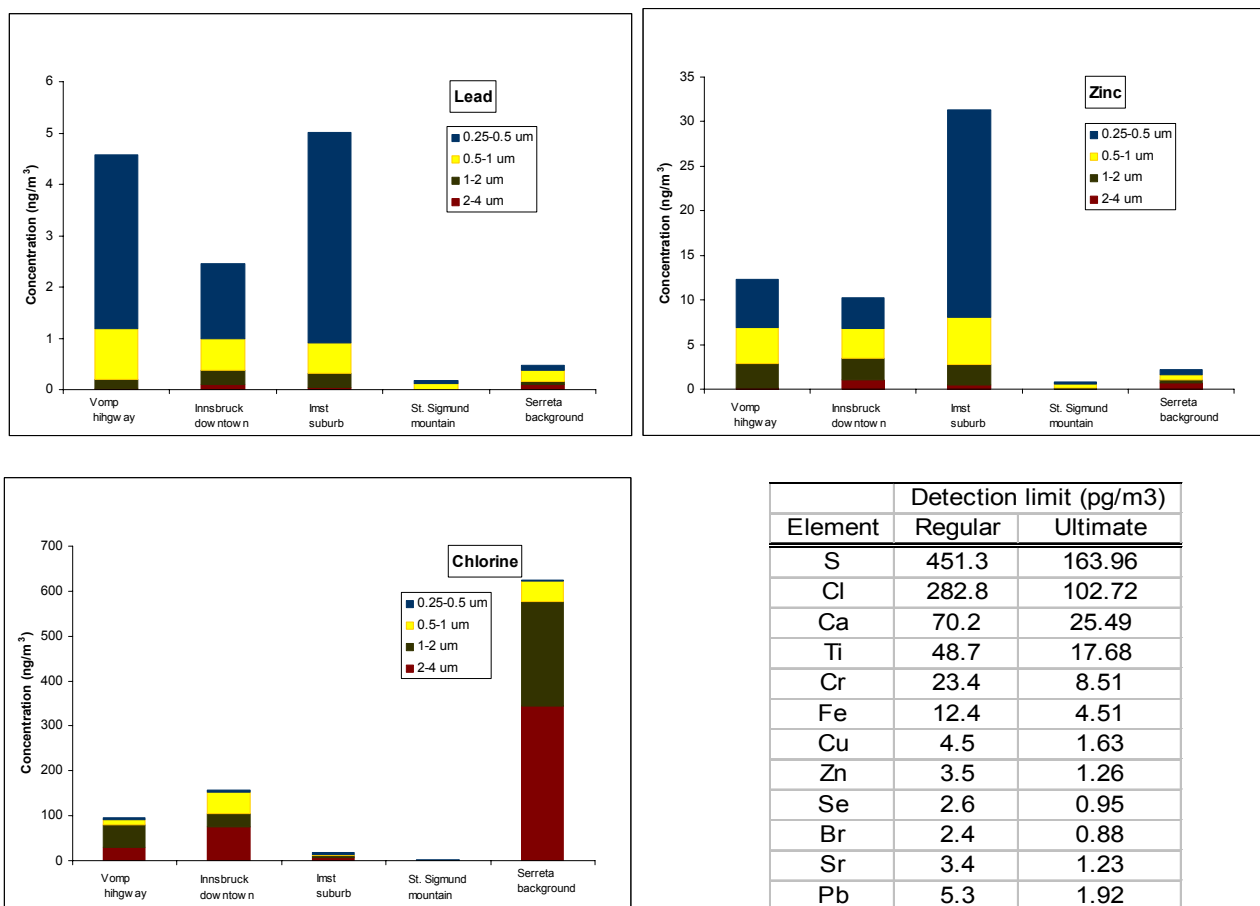


Figure 1. a-c. Size distribution of Pb, Zn and Cl concentrations at different sites, **Table 1.** Detection limits calculated for 1 m³ sample volume, 100 s measurement time and 100 mA ring current (Regular: sample strip perpendicular to the beam, Ultimate: sample strip parallel to the beam)

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